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THE PLANT DISEASE REPORTER

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THE EFFICACY OF FUNGICIDES IN THE CONTROL OF CERTAIN GENERA OF PLANT-PATHOGENIC FUNGI: A LITERATURE REIVEW

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Plant Disease Epidemics and Identification Section serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

PLANT DISEASE REPORTER SUPPLEMENT

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THE EPIDEMIOLOGY UNIT
PLANT DISEASE EPIDEMICS AND IDENTIFICATION SECTION

Horticultural Crops Research Branch Plant Industry Station, Beltsville, Maryland

THE EFFICACY OF FUNGICIDES IN THE CONTROL OF CERTAIN GENERA OF PLANT-PATHOGENIC FUNGI: A LITERATURE REVIEW[1]

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Is zineb equally effective or ineffective against species of Septoria occurring on celery, chrysanthemum and tomato? If a new disease caused by an undescribed species of Alternaria were to require chemical control measures, would control of the disease be expedited by a knowledge of which fungicide is most effective against Alternaria solani on tomato? The ~~answers~~ answers to these questions require a knowledge of the protective value of fungicides for the pathogens concerned and, perhaps, more fundamental knowledge of fungicide-pathogen specificities. The results of numerous field tests with fungicides have been well summarized (1, 2, 3, 4, 5, 6, 7, 8, 9), but the results are detailed by crops rather than by pathogens making it difficult without detailed study to arrive at any prediction as to fungicide-pathogen relationships. If comparative values or control-indices for most present-day fungicides against major groups of plant pathogens could be developed, such information might be extremely valuable if a new pathogen, regardless of source, should become epiphytotic on plants vital to our economy.

This paper is the result of an attempt to determine by means of a literature review if and to what extent several types of fungicides exhibit differences in the control of 23 plant-pathogenic species in four well-known genera of fungi. Despite the fact that considerable thought has been given to possible means of evaluation, the writers realize that criticism will be directed toward the evaluation-methods finally developed[3] and towards some of the conclusions. No attempt has been made to decide what fungicide should be recommended for controlling any particular species and none of the conclusions should be interpreted in this way. A recommendation as such is determined to a considerable extent by factors such as phytotoxicity, availability, and comparative costs and is primarily the "headache" of the individual pathologist.

The present survey covers the period 1942 to 1952 and includes tests reported from each of the 48 States and from Brazil, British Columbia, Costa Rica, Germany, Hawaii, Ontario, Switzerland and New Zealand. The year 1942 was chosen as the starting point primarily because it marks the beginning of extensive field testing of organic fungicides for the control of fruit and foliage diseases.

The 23 species of pathogenic fungi covered in this survey belong in the genera Alternaria, Cercospora, Colletotrichum, and Septoria. Several of the species in these genera are important pathogens and occur on a wide variety of plants. An attempt was made to include in the survey all species on which chemical control studies have been reported since 1942. However, the survey does not include data from experiments where it was apparent that more than one pathogen was present. The suscepts affected by these fungi are listed in Table 1.

Four fungicides were employed as standards with two or more used in developing the control-indices (Tables 3-8, 10). These standards (fixed copper, bordeaux mixture, ziram, and zineb) were chosen as such because they appear to have been used in a majority of tests against all pathogens included in the survey. For the results to be considered experiments had to include at least two standards with one of these an organic fungicide.

Fungicides were evaluated whenever possible by classes as shown in Table 2. Only those fungicides and mixtures shown in this Table were considered in developing control-indices. In several tests fungicides were applied in combination with insecticides. To reduce the variables arising under these circumstances, fungicides combined with insecticides other than DDT, parathion, or lead arsenate were not evaluated.

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[1] A revised and condensed version of a thesis submitted by the senior author in partial fulfillment of the requirements for the M. S. degree in the Graduate College of the University of Illinois.

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[3] Acknowledgement is made of the valuable assistance rendered by Dr. J. A. Jackobs, Department of Agronomy, University of Illinois, in developing the control-index formula.

Investigators have used various means of rating the efficiency of fungicides, thus making comparisons among tests exceedingly difficult. In summaries such as those in the Plant Disease Reporter Supplements, a few have employed the ratings "excellent," "good," "fair," and "poor," or a numerical rating system, while others have named the best fungicide without attempting further classification. A majority of tests has been reported in more specific terms, e.g., percent of infected leaves or fruit or percent defoliation.

Effectiveness of the fungicides in controlling the pathogen concerned was the only criterion employed in this survey. Any differences in efficacy, however small, were sufficient to rate the fungicide being evaluated as superior or inferior to the standards. The results of statistical analyses by individual investigators were not used in the evaluations since they were not provided in all instances. Rankings based on yield, phytotoxicity, and personal preferences were not considered for these may well be related to factors other than fungicidal specificity. Generalized summaries such as have appeared in the Plant Disease Reporter Supplements were employed only whenever it was apparent that these accounts were not superseded by publication of specific data elsewhere.

Although the writers have listed most of the literature consulted, no attempt has been made to give any but a few major citations for specific tests because of space limitations in the tables. Some idea of the complexity and scope of the evaluations can be gained from the fact that nearly 8,000 individual comparisons between compounds were made in computing all of the indices.

METHOD OF EVALUATION

The computation of the control-index for the fungicide to be evaluated is based on a series of comparisons of the disease control provided by the fungicide with the control obtained from the fungicide standards which happened to be in the test concerned. The control-index is computed from the equation, $C\text{-}I = \frac{((1 \times S) + (0.5 \times E)) \times 100}{T}$. In this equation S is the number of comparisons in which the fungicide to be evaluated was superior[4] to the fungicidal standard; E is the number of comparisons in which the fungicide and standard were equally effective; T is the total number of comparisons involved in the computation including those where inferior ratings were obtained; and 100 is an arbitrary constant used to avoid index values less than one. The value E was always multiplied by 0.5 to insure that equally effective control would be taken into account in calculating the index.

The following actual computation of a single control-index will serve to illustrate the way in which the formula is utilized. In 41 comparisons for control of Alternaria cucumerina, zineb was superior to fixed coppers 7 times, equally effective 13 times, and inferior 21 times. The control-index for zineb compared with fixed copper would be calculated from the formula as follows: $\frac{((7 \times 1) + (13 \times 0.5)) \times 100}{41} = 32.9$. The control-index and total number of comparisons of zineb with fixed copper appear in Table 3 as "33 (41)". Since the index is less than 50, this signifies that zineb was inferior to fixed copper in 41 comparisons. Contrariwise, an index higher than 50 would have indicated that zineb was superior to fixed copper.

The total control-index for a fungicide compared with all standards is computed according to the same formula but the components are obtained in a slightly different manner. The S values used in the calculation of the index under each standard are added to obtain the S utilized in calculating the total index for the fungicide being evaluated. The E and T values are handled similarly. The control-index for a genus is obtained by a summation of S, E, and T values from the species-indices.

Under this system fungicides with indices between 50 and 100 would be expected to give a moderate to high degree of control provided a total of 10 or more comparisons had been made.

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[4] The value 0 and letter I were chosen for each comparison in which the fungicide was inferior to the standard. However, these obviously have no effect in calculating the index and, therefore, can be ignored.

On the other hand, fungicides with indices below 50 would be less effective than the first group.

DISCUSSION

One inherent difficulty in attempting to rank the efficiency of a number of fungicides over a period of years is the probability that changes have been made in composition and formulation of the fungicides. It is apparent that such changes may influence not only fungicidal efficacy *per se* but also retentivity, coverage, and other physical and chemical properties of the fungicide. As Horsfall (32) has pointed out, a chemical may have a high fungicidal value but a low protective value if tenacity is poor. Fungicides containing zineb or dichlone can be cited as examples of those which have been modified since their introduction in order to increase the fungicidal or protective value or to decrease phytotoxicity.

Although a control-index of 50 or above indicates that a fungicide would provide moderate to good control, some consideration must be given to the number of comparisons, tests, and standards involved in the computation. Thus, the Manzate index of 82 based on 103 comparisons (Table 6 -- *C. phomoides*) is likely to have more significance than an index of 81 from 8 comparisons (Table 6 -- *C. lagenarium*). One might assume at first glance that C-O-Z would give a higher degree of control of *S. lycopersici* than the fixed coppers (Table 8). However, the C-O-Z index was derived from only one comparison with zineb, one with ziram (which is relatively ineffective against *Septoria* spp.), and two with fixed copper.

The validity of the method followed in computing the indices can be demonstrated by a comparison of the indices obtained against *Alternaria solani* on potatoes and on tomatoes (Table 4). Where fungicides had been used on both crops, the indices are in general agreement with the possible exception of those for bordeaux mixture.

The results of this survey indicate that Manzate is a very effective fungicide against most species in the four genera. They suggest also that very few of the organic fungicides are as effective as the copper compounds against *Cercospora* spp. and *Septoria* spp. The coppers appear to be relatively poor against *Colletotrichum* spp.

The writers were aware at the outset of this survey that the results, in whatever form expressed, would not always be in agreement with those obtained by individual investigators. One example of discrepancy is in the control of *Septoria lycopersici* with dichlone (Phygon) (Table 8). Nagel and Richardson (40) found that Phygon was definitely superior to Yellow Cuprocide, Dithane D-14 + zinc sulfate + lime, bordeaux mixture, Spergon, and Fermate in controlling this pathogen. Yet when all tests included in the present survey are considered, the index of 45 for dichlone is found to be somewhat below 62 for fixed copper and 54 for zineb. Actually *S. lycopersici* is one of the most difficult leaf-spot pathogens to control with the fungicides presently available. Thus, any commercially available fungicide with an index over 40 would be comparatively effective.

Although Neergaard (41) states that *Alternaria solani*, *A. dauci*, and *A. porri* generally differ only in pathogenicity, the compiled data suggest the possibility that the three species are dissimilar in their susceptibility to fungicides. Few comparisons are available for *A. porri* (Table 3) but the data indicate that zineb has a moderately high control-index against this species. In contrast, zineb would appear to be rather ineffective against *A. dauci* (Table 4). Ziram has a comparatively low index against *A. solani* (Table 4) and a high index against *A. dauci*. The reverse is true for zineb. Almost complete reversal in effectiveness is also apparent for ferbam against *Septoria apii* and *S. lycopersici* (Table 8). However, since these are distinct species, they might be expected to differ more in this respect than would forms of the same species.

It would appear impossible to use control data covering one species and to predict with any consistent degree of accuracy which type of fungicide would give best control of another species in the same genus. This conclusion is based on a reversal in effectiveness for zineb and ziram against *Alternaria dauci* and *A. solani*, as already noted, and against *Colletotrichum lindemuthianum* and *C. lagenarium*, and for ferbam against *Septoria apii* and *S. lycopersici*. However, if the writers had to choose a fungicide to control a new species in any of the four genera included in this survey with no time available for preliminary trials, they would select one of the two highest ranking types (Table 10). Such a choice should be more trustworthy than a random choice from among the more than 20 types of fungicides now available.

The degree of control with fungicides included in this survey (Table 9) agrees only in certain instances with the 1950 recommendations for disease control by pathologists in various States. For example, bordeaux mixture and the fixed coppers were predominant favorites (Table 11) for controlling most species of the four genera. Notable exceptions are *Alternaria* *brassicae* (ziram), *A. porri* (zineb), *Cercospora circumscissa* (ferbam), *C. cruenta* and *C. cruciferarum* (ferbam), *Colletotrichum gloeosporioides* (ferbam and Bioquin 1), *C. higginsianum* (chloranil), *C. phomoides* (ziram), *C. truncatum* (zineb), and *Septoria petroselini* (zineb). It should be pointed out that in 1950 such materials as maneb, captan, zineb, and dichlone were hardly past the experimental stage in their commercial development.

There are several explanations for a lack of agreement between the calculated efficacy from the present survey and the actual recommendations:

1. Newer and seemingly more effective fungicides are seldom recommended in preference to well-established protectants until they have been shown to give better disease control over a wide range of conditions. A minimum of three to four years would appear to be required for such evaluations.
2. Often a complex of diseases is considered in making a recommendation for a specific disease. Thus one would sacrifice some control of *Colletotrichum phomoides* (tomato anthracnose) by recommending zineb over ziram but would expect better control of *Stemphylium solani* (gray leaf spot), *Septoria lycopersici* (Septoria leaf spot), and *Phytophthora infestans* (late blight), The same would probably be true also for diseases of potatoes and cucurbits.
3. Cost differentials are often important. Thus one might hesitate in recommending a new and relatively expensive fungicide when a well-established and cheaper chemical was available, particularly if the margin of control for the new material were not exceptional.
4. Phytotoxicity rather than fungicidal or protective value may be the deciding factor in determining whether a fungicide will be recommended for use on a specific crop. This is reflected in the obvious hesitancy of pathologists to recommend bordeaux mixture for controlling *Colletotrichum lagenarium* on cucumber (Table 11) although they have considered this fungicide satisfactory against the pathogen on other cucurbits.
5. Availability and ease of mixing or use may be considerations, though minor ones, in deciding which of two materials to recommend.

Since research data show that two pathologists in adjoining States working with several identical fungicides can seldom agree on the order of fungicidal effectiveness against a specific pathogen, it is remarkable -- and fortunate -- that pathologists can agree as well as they have on recommendations for specific diseases.

SUMMARY

From the reported data on disease control over the period 1942-1952, an evaluation was made of the comparative effectiveness of 17 types (33 formulations) of fungicides against 23 plant-pathogenic species in four genera of fungi. Disease control was the sole criterion with no consideration given to phytotoxicity, undesirable residues, or cost. A formula was developed for calculating the control-index for each fungicide. Four standards (zineb, ziram, fixed copper, and bordeaux mixtures) were used as comparisons.

Manzate was found to be a very effective fungicide against most species. The copper fungicides in general ranked higher than the organic compounds against *Cercospora* spp. and *Septoria* spp. but were relatively ineffective against *Colletotrichum* spp. Individual variations in response to fungicides were noted among species in the same genus. There were indications that form species, said to be alike culturally and morphologically but differing in pathogenicity, are dissimilar in response to fungicides. The calculated control efficiency ratings of the fungicides were not in complete agreement with recommendations current at the end of the survey period. Reasons are advanced to account for the apparent discrepancies.

Table 1. Plant-pathogenic species[a] and suscepts included in survey.

Species	Suscepts
Alternaria brassicae (Berk.) Sacc. and *A. brassicicola* (Schw.) Wiltsh.	Cabbage, cauliflower
A. cucumerina (Ell. & Ev.) J. A. Elliott	Cucurbits
A. tenuis Auct.	Petunia
A. porri (Ell.) Cif.[b]	Onion
A. panax Whet.	Ginseng
A. dauci (Kuehn) Groves & Skolko	Carrot
A. dianthi F. L. Stevens & J. G. Hall	Carnation
A. solani (Ell. & G. Martin) L. R. Jones & Grout[c]	Potato, tomato
Cercospora apii Fres.	Celery
C. beticola Sacc.	Beet
C. carotae (Pass.) Solh.	Carrot
Colletotrichum lindemuthianum (Sacc. & Magn.) Briosi & Cav.	Garden bean
C. phomoides (Sacc.) Chester[d]	Tomato
C. lagenarium (Pass.) Ell. & Halst.	Cucurbits
C. truncatum (Schw.) Andrus & W. D. Moore	Lima bean
C. higginsianum Sacc.	Chinese cabbage
C. antirrhini Stewart	Snapdragon
Septoria apii (Briosi & Cav.) Chester and *S. apii-graveolentis* Dorogin	Celery
S. lycopersici Speg.	Tomato
S. chrysanthemi Allesch.	Chrysanthemum
S. leucanthemi Sacc. & Speg.	Chrysanthemum

[a] Names are those given in "Index of Plant Diseases in the United States," compiled by Freeman Weiss and Muriel J. O'Brien, Plant Dis. Survey Spec. Publ. 1: pp. 1-1192; index part (Muriel J. O'Brien and John A. Stevenson): pp. 1195-1263. 1950-1953.

[b] Synonym: *A. dauci* (Kuehn) Groves & Skolko f. sp. *porri* (Ell.) Neergaard (41).

[c] Synonym: *A. dauci* (Kuehn) Groves & Skolko f. sp. *solani* (Ell. & G. Martin) Neergaard (41).

[d] The perfect stage has recently been found and named *Glomerella phomoides* (Sacc.) Swank; Phytopath. 43: 285-287. 1953.

Table 2. Names, active ingredients, classification and codes for fungicides included in survey[a].

Common or proprietary name	Active ingredients	Classification	Code (Tables 3-12)
1. Basicop	Basic copper sulfate	Fixed copper[d]	Fxc
2. Bioquin 1	Copper 8-quinolinolate	Organic copper	Bio 1
3. Bordeaux mixture	Unknown	Bordeaux[d]	Bordo
4. Copper A	Copper oxychloride	Fixed copper	Fxc
5. C-O-C-S	Copper oxychloride sulfate	Fixed copper	Fxc
6. Cop-O-Zink	Copper and zinc sulfates	Cop-O-Zink	C-O-Z
7. Copper-lime dust	Unknown	Bordeaux	Bordo
8. Crag 658	Copper zinc chromate	CuZn chromate	658
9. Dithane D-14 + $ZnSO_4$	Zinc ethylene bisdithiocarbamate	Zineb[d]	Zineb
10. Dithane D-14 + $ZnSO_4$ + lime	Zinc ethylene bisdithiocarbamate	Zineb[d]	Zineb

Table 2. (Continued).

Common or proprietary name	Active ingredients	Classification	Code (Tables 3-12)
11. Dithane Z-78	Zinc ethylene bisdithiocarbamate	Zineb	Zineb
12. Fermate	Ferric dimethyl dithiocarbamate	Ferbam	Ferbam
13. Karbam black	Ferric dimethyl dithiocarbamate	Ferbam	Ferbam
14. Karbam white	Zinc dimethyl dithiocarbamate	Ziram[d]	Ziram
15. Manzate or MnEBD	Manganese ethylene bisdithiocarbamate	Maneb	Maneb
16. Methasan, S or W	Zinc dimethyl dithiocarbamate	Ziram	Ziram
17. Orthocide 406 or SR-406	N-trichloromethyl-mercapto-4-cyclohexene-1, 2-dicarboximide	Captan	Captan
18. Parzate (dry)	Zinc ethylene bisdithiocarbamate	Zineb	Zineb
19. Parzate (liquid) + $ZnSO_4$	Zinc ethylene bisdithiocarbamate	Zineb	Zineb
20. Phelps Dodge copper	Basic copper sulfate	Fixed copper	Fxc
21. Phygon or Phygon-XL	2, 3 dichloro-1, 4 naphthoquinone	Dichlone	Dichlone
22. Robertson copper	Metallic copper and cuprous oxide	Fixed copper	Fxc
23. Spergon (wettable)	Tetrachloro-para-benzoquinone	Chloranil	Chloranil
24. Spraycop	Basic copper sulfate	Fixed copper	Fxc
25. SDDC[b] + $FeSO_4$	Ferric dimethyl dithiocarbamate	Ferbam	Ferbam
26. SDDC[b] + $MnSO_4$	Manganese dimethyl dithiocarbamate	SDDC + $MnSO_4$	SDDC + Mn
27. Tennessee Tri-Basic $CuSO_4$	Basic copper sulfate	Fixed copper	Fxc
28. Tersan	Tetramethyl thiuram disulfide	Thiram	Thiram
29. Vancide 51 + $ZnSO_4$ (Vancide ZW)	(Na salts dimethyl dithiocarbamate) + $ZnSO_4$	Vancide ZW	Van ZW
30. Vancide 51 + $MnSO_4$	(and 2-mercapto-benzothiazole) + $MnSO_4$	Vancide MW	Van MW
31. Yellow Cuprocide	Cuprous oxide	Fixed copper	Fxc
32. Zac or Zac S	Zinc dimethyl dithiocarbamate-cyclohexylamine	Zac	Zac
33. Zerlate	Zinc dimethyl dithiocarbamate	Ziram	Ziram

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[a] Crag 341, Tag 331, Isothan Q-15, Actidione, lime-sulfur, and sulfur were also used in a minority of tests but none is considered to be equal to the fungicides listed in Table 11 in protective value against the species concerned.

[b] Sodium dimethyl dithiocarbamate.

[c] Formerly identified as N-trichloromethylthio tetrahydrophthalimide.

[d] Two or more of these classes were used as standards in Tables 3-10.

Table 3. Control-indices of fungicides tested against Alternaria brassicae, A. brassicicola A. cucumerina, A. tenuis, A. porri, and A. panax (1942-52).

Evaluated fungicides	Control-indices of evaluated fungicides compared with standards				
	Zineb	Ziram	Fxc	Bordo	Total
A. brassicae and A. brassicicola					
Zineb	--	33(6)	100(7)	--	69(13)
Ziram	67(7)[a]	--	83(6)	--	75(12)
Fxc	0(7)	17(6)	--	--	8(13)
Ferbam	0(3)	0(3)	100(5)	--	46(11)
Dichlone	0(1)	0(1)	0(1)	--	0(3)
658	0(1)	0(1)	75(2)	--	38(4)
Thiram	0(3)	0(3)	100(5)	--	46(11)
Chloranil	0(5)	0(4)	83(6)	--	33(15)
A. cucumerina					
Zineb	--	61(22)	33(41)	11(14)	37(77)
Ziram	39(22)	--	39(18)	0(7)	33(47)
Fxc	67(41)	61(18)	--	23(11)	52(70)
Bordo	89(14)	100(7)	77(11)	--	88(32)
Maneb	0(2)	--	0(1)	0(1)	0(4)
Captan	100(1)	50(1)	100(2)	--	88(4)
Dichlone	17(3)	25(2)	25(2)	0(2)	17(9)
A. tenuis					
Zineb	--	50(3)	--	100(1)	63(4)
Ziram	50(3)	--	--	0(1)	37(4)
Bordo	0(1)	100(1)	--	--	50(2)
Ferbam	0(2)	0(1)	--	--	0(3)
A. porri					
Zineb	--	--	70(10)	33(3)	71(13)
Fxc	30(10)	--	--	0(1)	27(11)
Bordo	67(3)	--	100(1)	--	75(4)
Maneb	0(2)	--	0(3)	--	0(5)
Ferbam	50(1)	--	100(1)	0(1)	50(3)
A. panax					
Fxc	--	--	--	0(4)	0(4)
Bordo	--	--	100(4)	--	100(4)
Ferbam	--	--	100(4)	0(1)	80(5)

[a] Numbers in parentheses indicate numbers of comparisons upon which indices are based.

Table 4. Control-indices of fungicides tested against *Alternaria dauci, A. dianthi*, and *A. solani* (1942-52).

Evaluated fungicide	Control-indices of evaluated fungicides compared with standards				
	Zineb	Ziram	Fxc	Bordo	Total
			A. dauci		
Zineb	--	29(14)	55(21)	60(5)	46(40)
Ziram	71(14)[a]	--	86(11)	100(2)	80(27)
Fxc	45(21)	14(11)	--	13(8)	30(40)
Bordo	40(5)	0(2)	87(8)	--	60(15)
Maneb	100(6)	67(3)	50(2)	--	82(11)
Ferbam	100(2)	--	100(5)	0(3)	70(10)
Captan	50(2)	0(2)	100(3)	100(1)	63(8)
658	100(4)	100(2)	50(2)	--	88(8)
Zac	50(2)	25(2)	100(3)	100(1)	79(8)
C-0-Z	0(3)	0(1)	0(1)	--	0(5)
Van ZW	33(3)	0(1)	0(1)	--	20(5)
			A. dianthi		
Zineb	--	83(9)	93(15)	50(6)	82(30)
Ziram	17(9)	--	86(7)	33(3)	45(19)
Fxc	7(15)	14(7)	--	0(5)	7(27)
Bordo	50(6)	67(3)	100(5)	--	73(14)
Maneb	0(1)	0(1)	--	0(1)	0(3)
Ferbam	0(2)	33(3)	--	0(1)	17(6)
Dichlone	11(9)	30(5)	0(7)	17(3)	13(24)
Van ZW	75(2)	100(2)	--	--	88(4)
			A. solani on potatoes		
Zineb	--	81(212)	93(318)	81(53)	88(583)
Ziram	19(212)	--	67(187)	55(23)	42(422)
Fxc	7(318)	33(187)	--	34(40)	18(545)
Bordo	19(53)	45(23)	66(40)	--	41(116)
Maneb	37(68)	38(38)	91(70)	100(6)	60(182)
Ferbam	0(2)	0(3)	67(3)	0(1)	22(9)
Captan	--	0(1)	--	100(1)	50(2)
Dichlone	0(18)	10(10)	34(12)	10(10)	15(50)
658	20(87)	62(42)	72(74)	61(14)	49(217)
Zac	20(50)	53(33)	70(37)	50(1)	45(121)
C-O-Z	15(62)	67(38)	80(54)	30(5)	50(159)
Van ZW	23(39)	35(31)	86(38)	100(1)	49(109)
Van MW	0(4)	0(5)	88(8)	--	41(17)
			A. solani on tomatoes		
Zineb	--	74(143)	59(168)	32(47)	70(358)
Ziram	26(143)	--	42((106)	21(26)	32(275)
Fxc	41(168)	58(106)	--	14(34)	41(308)
Bordo	68(47)	79(26)	86(34)	--	76(107)
Maneb	59(40)	79(27)	83(30)	50(4)	72(101)
Ferbam	18(19)	0(20)	22(9)	0(5)	10(53)
Captan	17(6)	50(6)	88(4)	--	28(16)
Dichlone	47(38)	47(16)	30(27)	18(11)	38(92)
658	34(56)	48(38)	30(55)	14(7)	37(156)
Zac	0(34)	26(39)	9(27)	0(2)	12(102)
C-O-Z	33(23)	68(19)	43(22)	0(3)	44(67)
Van ZW	21(7)	50(14)	87(6)	--	50(27)
Van MW	0(4)	0(8)	--	--	0(12)
SDDC + Mn	0(2)	50(4)	--	--	33(6)
Bio 1	37(8)	100(3)	50(4)	100(2)	59(17)

[a] Numbers in parentheses indicate numbers of comparisons upon which indices are based.

Table 5. Control-indices of fungicides tested against *Cercospora apii*, *C. beticola*, *C. carotae* (1942-52).

Evaluated fungicide	Control-indices of evaluated fungicides compared with standards				
	Zineb	Ziram	Fxc	Bordo	Total
			C. apii		
Zineb	--	45(50)	33(51)	33(12)	39(113)
Ziram	55(50)[a]	--	56(36)	36(7)	54(93)
Fxc	67(51)	44(36)	--	31(16)	53(103)
Bordo	67(12)	64(73)	69(16)	--	67(101)
Maneb	100(7)	25(4)	50(6)	0(1)	61(18)
Ferbam	52(12)	41(11)	41(17)	17(3)	45(43)
Captan	100(1)	50(2)	40(5)	0(1)	44(9)
Dichlone	20(10)	19(8)	12(13)	20(5)	17(36)
658	0(2)	0(2)	0(2)	--	0(6)
Zac	0(9)	10(10)	0(4)	50(1)	6(24)
C-O-Z	11(9)	0(7)	0(5)	--	5(21)
Chloranil	0(1)	0(2)	0(1)	--	0(4)
Bio 1	75(2)	0(1)	--	0(1)	37(4)
			C. beticola		
Zineb	--	--	0(2)	--	0(2)
Fxc	100(2)	--	--	--	100(2)
Ferbam	100(1)	--	0(2)	--	33(3)
			C. carotae		
Zineb	--	27(15)	56(18)	33(6)	39(39)
Ziram	73(15)	--	85(10)	67(30)	77(28)
Fxc	44(18)	15(10)	--	8(12)	23(40)
Bordo	67(6)	33(3)	92(12)	--	76(21)
Maneb	100(5)	67(3)	50(2)	--	80(10)
Ferbam	100(2)	--	100(9)	0(4)	73(15)
Captan	50(2)	0(2)	100(3)	100(1)	63(8)
Dichlone	0(2)	0(1)	--	0(1)	0(4)
658	100(3)	100(1)	0(2)	--	67(6)
Zac	50(2)	25(2)	100(3)	100(1)	69(8)
C-O-Z	0(3)	--	0(1)	--	0(4)
Van ZW	33(3)	0(1)	0(1)	--	20(5)

[a] Numbers in parentheses indicate numbers of comparisons upon which indices are based.

Table 6. Control-indices of fungicides tested against *Colletotrichum lindemuthianum*, *C. phomoides* and *C. lagenarium* (1942-52).

Evaluated fungicides	Control-indices of evaluated fungicides compared with standards				
	Zineb	Ziram	Fxc	Bordo	Total
			C. lindemuthianum		
Zineb	--	0(3)	100(1)	33(3)	28(7)
Ziram	100(3)[a]	--	--	100(3)	100(6)
Fxc	0(1)	--	--	0(1)	0(2)
Bordo	67(3)	0(3)	100(1)	--	43(7)
Ferbam	33(6)	0(3)	100(1)	67(3)	38(13)
Dichlone	67(3)	--	100(1)	--	75(4)
			C. phomoides		
Zineb	--	29(184)	82(153)	61(38)	55(375)
Ziram	71(184)	--	92(111)	88(21)	80(316)
Fxc	18(153)	8(111)	--	25(26)	15(290)
Bordo	29(38)	12(21)	75(26)	--	35(85)
Maneb	72(46)	85(33)	96(24)	--	82(103)
Ferbam	42(19)	11(27)	94(11)	57(7)	43(64)
Captan	62(13)	79(7)	100(8)	--	77(28)
Dichlone	19(16)	11(9)	7(10)	8(12)	28(47)
658	20(45)	9(37)	45(41)	0(2)	24(125)
Zac	70(46)	32(47)	87(30)	100(2)	67(125)
C-O-Z	0(23)	5(22)	39(14)	--	19(59)
Van ZW	0(10)	37(12)	40(5)	--	24(27)
Van MW	0(6)	0(8)	--	--	0(14)
SDDC+Mn	0(2)	50(4)	--	--	33(6)
Bio 1	40(5)	0(2)	100(1)	100(2)	50(10)
			C. lagenarium		
Zineb	--	78(12)	96(24)	87(4)	90(40)
Ziram	22(12)	--	65(10)	50(2)	42(24)
Fxc	4(24)	35(10)	--	25(4)	14(38)
Bordo	13(4)	50(2)	75(4)	--	45(10)
Maneb	63(4)	100(3)	100(1)	--	81(8)
Ferbam	37(19)	50(5)	68(14)	67(3)	51(41)
Captan	40(10)	100(1)	100(5)	--	63(16)
Dichlone	0(2)	--	100(1)	--	33(3)
658	10(10)	33(3)	60(6)	--	28(19)
Zac	0(2)	0(1)	0(2)	--	0(5)
C-O-Z	0(4)	--	75(2)	--	25(6)
Van ZW	0(2)	0(2)	--	--	0(4)

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[a] Numbers in parentheses indicate numbers of comparisons upon which indices are based.

Table 7. Control-indices of fungicides tested against *Colletotrichum truncatum*, *C. higginsianum* and *C. antirrhini*.

Evaluated fungicides	Control-indices of evaluated fungicides compared with standards				
	Zineb	Ziram	Fxc	Bordo	Total
			C. truncatum		
Zineb	--	100(3)	100(1)	--	100(4)
Ziram	0(3)[a]	--	0(1)	--	0(4)
Fxc	0(1)	100(1)	--	--	50(2)
Ferbam	0(2)	100(2)	0(1)	--	40(6)
Dichlone	67(3)	100(3)	100(1)	--	86(7)
			C. higginsianum		
Zineb	--	75(4)	--	--	75(4)
Ziram	25(4)	--	--	--	25(4)
Ferbam	0(2)	50(2)	--	--	25(4)
Chloranil	67(3)	67(3)	--	--	67(6)
			C. antirrhini		
Zineb	--	--	--	100(1)	100(1)
Bordo	0(1)	--	--	--	0(1)
Ferbam	0(1)	--	--	--	0(1)

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[a] Numbers in parentheses indicate numbers of comparisons upon which indices are based.

Table 8. Control-indices of fungicides tested against *Septoria apii*, *S. apii-graveolentis*, *S. chrysanthemi*, *S. leucanthemi* and *S. lycopersici* (1942-52).

Evaluated fungicides	Control-indices of evaluated fungicides compared with standards				
	Zineb	Ziram	Fxc	Bordo	Total
			S. apii and *S. apii-graveolentis*		
Zineb	--	50(4)	0(5)	0(1)	20(10)
Ziram	50(4)[a]	--	30(5)	--	39(9)
Fxc	100(5)	70(5)	--	50(5)	71(15)
Bordo	100(1)	--	50(5)	--	58(6)
Ferbam	100(1)	--	100(6)	100(3)	100(10)
Dichlone	50(4)	50(1)	25(2)	--	43(7)
			S. chrysanthemi		
Zineb	--	50(1)	--	--	50(1)
Ziram	50(1)	--	--	--	50(1)
Fxc	50(1)	--	--	0(2)	35(3)
Bordo	--	--	100(2)	--	100(2)
Maneb	50(3)	--	--	--	50(3)
Ferbam	50(3)	50(1)	100(2)	100(1)	72(7)
Captan	50(2)	--	--	--	50(2)
Dichlone	50(1)	50(1)	--	--	50(2)
Zac	0(1)	--	--	--	0(1)
Van ZW	50(1)	50(1)	--	--	50(2)
Bio 1	50(1)	--	--	--	50(1)
			S. leucanthemi		
Zineb	--	--	0(1)	--	0(1)
Fxc	100(1)	--	--	--	100(1)
Van ZW	100(1)	--	50(1)	--	75(2)
			S. lycopersici		
Zineb	--	75(8)	52(23)	39(9)	54(40)
Ziram	25(8)	--	6(8)	25(4)	18(20)
Fxc	48(23)	94(8)	--	69(8)	62(39)
Bordo	61(9)	75(4)	31(8)	--	53(21)
Maneb	32(17)	50(1)	80(10)	33(6)	48(34)
Ferbam	25(2)	0(1)	0(4)	50(3)	20(10)
Captan	13(8)	--	50(4)	0(1)	28(13)
Dichlone	50(10)	70(5)	32(11)	42(6)	45(32)
658	50(2)	100(1)	0(3)	0(2)	25(8)
C-O-Z	100(1)	100(1)	100(2)	--	100(4)
Van ZW	0(2)	--	--	--	0(2)
Van MW	0(2)	--	--	--	0(2)
Chloranil	0(2)	0(1)	0(3)	25(2)	6(8)

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[a] Numbers in parentheses indicate numbers of comparisons upon which indices are based.

Table 9. Summary of degree of control with fungicides of 23 pathogens based on indices in Tables 3 and 8. Possible phytotoxicity and undesirable residues not considered (1942-52).

Pathogen	Fungicides	
	Moderate to good control	Promising[a]
Alternaria brassicae[b]	Ziram, Zineb	Captan, Maneb, Zac, Van ZW
A. cucumerina	Captan[c], Bordo, Fxc	Maneb, Zac, Van ZW, 658, Ferbam
A. tenuis	Zineb[c] Bordo[c]	Zac, Van ZW, 658, Captan, Maneb
A. porri	Bordo[c], Zineb	Captan, 658, Zac, Van ZW, Maneb, Ziram
A. panax	Bordo[c], Ferbam[c]	Captan, 658, Zac, Van ZW, Maneb, Ziram, Zineb
A. dauci	658[c], Maneb, Ziram, Zac[c], Ferbam	Captan, Van ZW
A. dianthi	Van ZW[c], Zineb, Bordo	Maneb, Captan, 658, Zac
A. solani on potatoes	Zineb, Maneb	Captan
A. solani on tomatoes	Bordo, Maneb, Zineb	
Cercospora apii	Bordo, Maneb, Ziram, Fxc	Captan, 658
C. beticola	Fxc	Maneb, Ziram, Captan, 658, Zac
C. carotae	Maneb, Ziram, Bordo	Captan, 658, Zac
Colletotrichum lindemuthianum	Ziram[c], Dichlone[c]	Maneb, Captan, Zac
C. phomoides	Maneb, Ziram, Captan, Zac, Zineb	
C. lagenarium	Zineb, Maneb[c]	Dichlone, Zac, Van ZW
C. truncatum	Zineb[c], Dichlone[c]	Maneb, Ziram, Captan, Zac, Van ZW
C. higginsianum	Zineb[c], Chloranil[c]	Maneb, Captan, Dichlone, Zac, Van ZW, Ziram
C. antirrhini	Zineb[c]	Maneb, Ziram, Captan, Dichlone, Zac, Van ZW
Septoria apii[d]	Ferbam, Fxc, Bordo[c]	Maneb, Dichlone, Van ZW, C-O-Z
S. lycopersici	C-O-Z[c], Fxc, Zineb, Bordo, Maneb, Dichlone	Van ZW
S. chrysanthemi	Bordo[c], Ferbam[c]	Maneb, Dichlone, Van ZW, C-O-Z, Zineb, Fxc
S. leucanthemi	Fxc[c], Van ZW[c]	Maneb, Dichlone, C-O-Z, Zineb, Ferbam

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[a] Indicates need for testing or retesting based on performance against this or other species in genus.

[b] Includes *A. brassicicola*.

[c] Based on less than 10 comparisons with standards.

[d] Includes S. *apii-graveolentis*.

Table 10. Summary of control-indices of fungicides aginst the genera *Alternaria*, *Cercospora*, *Colletotrichum*, and *Septoria*, with order based solely on indices in Tables 3-8.

Genera, evaluated fungicides and total control-indices							
Alternaria spp.		*Cercospora* spp.		*Colletotrichum* spp.		*Septoria* spp.	
Zineb	76(118)[a]	Bordo	71(122)	Maneb	82(111)	C-O-Z	100(4)
Maneb	62(306)	Maneb	70(28)	Ziram	76(354)	Fxc	63(57)
Bordo	62(294)	Ziram	59(121)	Captan	72(44)	Ferbam	63(27)
Bio 1	59(17)	Captan	53(17)	Chloranil	67(6)	Bordo	57(29)
Van ZW	49(145)	Ferbam	51(61)	Zineb	59(431)	Bio 1	50(1)
C-O-Z	47(231)	Fxc	47(145)	Zac	58(130)	Maneb	49(37)
Captan	47(30)	Zineb	38(154)	Bio 1	50(10)	Zineb	46(52)
Ziram	46(806)	Bio 1	37(4)	Ferbam	44(129)	Dichlone	45(41)
Thiram	46(11)	658	33(12)	Dichlone	39(61)	Van ZW	42(6)
658	44(385)	Zac	24(32)	Bordo	36(103)	Captan	32(15)
Chloranil	33(15)	Van ZW	20(5)	SDDC+Mn	33(6)	Ziram	25(30)
SDDC+Mn	33(6)	Dichlone	15(40)	658	25(144)	658	25(8)
Zac	31(231)	C-O-Z	4(25)	Van ZW	21(31)	Chloranil	13(8)
Ferbam	30(100)	Chloranil	0(4)	Fxc	15(332)	Van ZW	0(2)
Fxc	26(1018)			C-O-Z	11(65)	Zac	0(1)
Dichlone	26(178)			Van MW	0(14)		
Van MW	24(29)						

[a] Numbers in parentheses indicate numbers of comparisons upon which indices are based.

Table 11. Summary of fungicides recommended[a] for control of species of *Alternaria*, *Cercospora*, *Colletotrichum* and *Septoria* by pathologists in various states. 1950.

Pathogen	Crop	No. of times fungicide given as 1st choice							
		Bordo	Fxc	Ferbam	Ziram	Zineb	Bio 1	Chloranil	Dichlone
Alternaria brassicae	Cabbage	1	1	--	2	--	--	1	--
	Cauliflower	1	1	--	1	--	--	1	--
	Broccoli	--	1	--	2	--	--	1	--
	Brussels Sprouts	1	1	1	2	--	--	1	--
	Kohlrabi	--	1	--	--	--	--	1	--
	Collards	--	1	--	--	--	--	1	--
	Horseradish	1	--	--	--	--	--	--	--
A. cucumerina	Squash & Pumpkin	4	6	--	1	2	--	--	--
	Cantaloupe	1	--	--	--	--	--	--	--
	Watermelon	1	--	--	--	--	--	--	--
A. porri	Onion	1	--	--	--	2	--	--	--
A. solani	Potato	16	2	--	3	8	--	--	--
	Tomato	8	9	--	6	4	--	--	--
	Eggplant	1	--	--	--	--	--	--	—
Alternaria spp. (Total)		36	23	1	17	16	--	6	--

Table 11. (Continued).

Pathogen	Crop	No. of times fungicide given as 1st choice							
		Bordo	Fxc	Ferbam	Ziram	Zineb	Bio 1	Chloranil	Dichlone
Cercospora apii	Celery	10	2	--	--	2	--	--	--
C. aurantia	Citrus	1	--	--	--	--	--	--	--
C. beticola	Beet	4	--	--	--	--	--	--	--
	Spinach	1	--	--	--	--	--	--	--
	Swiss Chard	--	--	--	--	1	--	--	--
C. capsici	Pepper	6	4	1	--	2	--	--	--
C. circumscissa	Cherry	--	--	2	--	--	--	--	--
C. citrullina	Watermelon	1	--	--	--	--	--	--	--
C. cruenta	Snap Bean	--	--	1	--	--	--	--	--
C. cruciferarum	Radish	--	--	1	--	--	--	--	--
C. fici	Fig	1	--	--	--	--	--	--	--
C. mali	Apple	1	--	--	--	--	--	--	--
C. obscura	Artichoke	1	--	--	--	--	--	--	--
C. purpurea	Avocado	--	1	--	--	--	--	--	--
C. rubi	Blackberry	1	--	--	--	--	--	--	--
C. viticola	Grape	1	--	--	--	--	--	--	--
Cercospora spp. (Total)		28	7	5	--	5	--	--	--
Colletotrichum	Citrus								
gloeosporioides	Citrus	1	--	--	--	--	--	--	--
	Guava	--	--	1	--	--	--	--	--
	Mango	--	--	--	--	--	1	--	--
	Papaya	--	--	1	--	--	--	--	--
C. gossypii[b]	Date Palm	1	--	--	--	--	--	--	--
C. higginsianum	Turnip	--	--	--	--	--	--	1	--
C. lagenarium	Cucumber	1	5	--	4	2	--	--	--
	Muskmelon	6	4	--	4	3	--	--	--
	Squash & Pumpkin	1	--	--	--	--	--	--	--
	Watermelon	7	6	1	2	--	--	--	--
C. phomoides	Tomato	--	2	--	15	2	--	--	--
C. lindemuthianum	Snap Bean	4	--	2	--	2	--	--	1
C. truncatum	Lima Bean	1	--	--	--	2	--	--	--
Colletotrichum spp. (Total)		22	17	5	25	11	1	1	1
Septoria apii	Celery	8	1	--	1	1	--	--	--
S. lycopersici	Tomato	9	10	--	--	4	--	--	--
S. petroselini	Parsley	--	--	--	--	1	--	--	--
S. rubi	Raspberry	4	--	2	--	--	--	--	--
Septoria spp. (Total)		21	11	2	1	6	--	--	--

[a] Compiled from "The control of fruit and vegetable diseases" by G. L. McNew, S. F. A. McCallan and P. R. Miller, 1951. Boyce Thompson Inst. Reprint 694: 61 pp. (Tables 13-61).

[b] *Colletotrichum gloeosporioides* (?).

Selected References

1. American Phytopathological Society, Sub-committee on "Summation of the performance of newer fungicides." 1948. 1947 fungicide tests. Plant Dis. Reptr. Suppl. 176. (Mimeogr.)
2. ______________________________. 1948. Report of the special committee on the coordination of field tests with new fungicidal sprays and dusts, with reference to results obtained in 1947. Plant Dis. Reptr. Suppl. 174. (Mimeogr.)
3. ______________________________. Sub-committee on "Summation of the performance of newer fungicides." 1949. Nation-wide results with fungicides in 1948. Fourth annual report. Plant Dis. Reptr. Suppl. 181. (Mimeogr.)
4. ______________________________. 1949. Second annual report of the special committee of the American Phytopathological Society on the coordination of field tests with new fungicidal sprays and dusts, with reference to the results obtained in 1948. Plant Dis. Reptr. Suppl. 183. (Mimeogr.)
5. ______________________________. 1950. Third annual report of the special committee of the American Phytopathological Society on the coordination of field tests with fungicidal sprays and dusts, with reference to the results obtained in 1949. (Mimeogr.)
6. ______________________________. Sub-committee on testing and results of newer fungicides. 1950. Nation-wide results with fungicides in 1949. Fifth annual report. Plant Dis. Reptr. Suppl. 192.
7. ______________________________. Sub-committee on testing and results of newer fungicides. 1952. 1950 summary of results of fungicide tests on crops other than fruit trees. Plant Dis. Reptr. Suppl. 210.
8. ______________________________. Sub-committee on testing and results of newer fungicides. 1952. 1951 summary of results of fungicide tests in the United States and Canada. Plant Dis. Reptr. Suppl. 213.
9. ______________________________. Advisory committee on collecting and disseminating data on new fungicide tests. 1954. Results of 1953 fungicide tests. Agr. Chem. 9 Nos. 1, 2, 3.
10. Beach, W. S. 1950. Tomato spraying in Pennsylvania. Pennsylvania Agr. Exp. Sta. Bul. 531.
11. Borders, H. I. 1951. Tests of fungicides for the control of tomato plant diseases in South Georgia, 1949-50. Plant Dis. Reptr. 35: 98-101.
12. Cox, R. C. 1948. Stem anthracnose on lima beans and its control (Abs.) Phytopath 38: 7.
13. _________. 1949. Further studies on stem anthracnose on lima beans in North Carolina. (Abs.) Phytopath 39: 5.
14. _________. 1950. Stem anthracnose on lima beans. North Carolina Agr. Exp. Sta. Tech. Bul. 90.
15. Dimock, A. W. 1943. Coming up-to-date on Verticillium wilt and Septoria leaf spot on chrysanthemum. Amer. Chrysanth. Soc. Bul. 11 (1): 3-10.
16. ____________. 1946. Disease control on chrysanthemum stock plants. American Chrysanth. Soc. Bul. 14 (1): 14-18.
17. ____________. 1947. Diseases in commercial flower production can be controlled. Flor. Exch. and Hort. Trade World 108 (23): 17, 36, 53.
18. ____________. 1948. Chrysanthemum and carnation disease control. Flor. Exch. and Hort. Trade World 111 (23): 18, 59-61.
19. ____________. 1948. Parzate. New York State Flower Growers Bul. 31: 8.
20. ____________. and H. Allyn. 1944. Dipping rooted chrysanthemum cuttings in Fermate for Septoria leaf spot. Amer. Chrysanth. Soc. Bul. 12 (2): 9-11.
21. Eddins, A. H. 1948. Alternaria leaf spot of cabbage and other crucifers. Florida Agr. Exp. Sta. Ann. Rept. 1948: 111-113.
22. ____________, and J. W. Wilson. 1948. Cercospora blight of celery. Florida Agr. Exp. Sta. Ann. Rept. 1948: 140.

23. Foster, A. A. 1947. Alternaria leaf spot of cabbage and other crucifers. Florida Agr. Expt. Sta. Ann. Rept. 1947: 142.

24. __________. 1947. Early blight of celery. Florida Agr. Exp. Sta. Ann. Rept. 1947: 140.

25. Godfrey, G. H. 1945. Onion leaf blotch reduced by spraying. Plant Dis. Reptr. 29: 652-654.

26. Hendrix, J. W., M. Matsuura, and K. Kikuta. Fungicide investigations. Hawaiian Agr. Exp. Sta. Bienn. Rept. 1944-46: 104-107.

27. Heuberger, J. W. 1947. Suggestions on planning tomato disease control programs. Food Packer and Canning Age 28 (7): 59-61.

28. __________. 1951. Eight years of Dithane vs. copper on potatoes in Delaware. (Abs.). Phytopath. 41: 561-562.

29. __________, S. H. Davis, Jr., L. P. Nichols, and L. D. Beuhler. 1947. Zinc ethylene bisdithiocarbamate as a fungicide on vegetables. (Abs.). Phytopath. 37: 9.

30. __________, and L. A. Stearns. 1947. New organic fungicides and insecticides for potatoes. (Abs.). Phytopath. 37: 9.

31. __________, and D. O. Wolfenbarger. 1944. Zinc dimethyl dithiocarbamate and the control of early blight and anthracnose on tomatoes and of leafhoppers and early blight on potatoes. (Abs.). Phytopath. 34: 1003.

32. Horsfall, J. G. 1945. Fungicides and their action. p. 50, Chronica Botanica Co., Waltham, Mass.

33. Linn, M. B., and R. G. Emge. 1949. Development of anthracnose and secondary rots in stored tomato fruits in relation to field spraying with fungicides. Phytopath. 39: 898-906.

34. Lyle, J. A., snd J. W. Hendrix. 1949. Control of tomato diseases. Hawaiian Agr. Exp. Sta. Bienn. Rept. 1946-48: 117.

35. McClean, D. M., and D. H. Bjornseth. 1947. Control of anthracnose on cannery tomatoes -- two years results. Michigan Agr. Exp. Sta. Quart. Bul. 28 (4): 287-293.

36. __________, and __________. 1943. IX. Effect of different fungicides on leaf blight and yield of tomatoes. The Canner 96 (15): 12-14, 24, 26, 28.

37. __________, and __________. 1943. XII. The control of anthracnose on cannery tomatoes. The Canner 96 (18): 16, 17, 26-28.

38. McNew, G. L. 1944. Bean anthracnose checked by new spray. Farm Res. 10: 19.

39. Muncie, J. H., M. R. Hatfield, and S. F. Morofsky. 1949. Field tests of new potato fungicides. Michigan Agr. Exp. Sta. Quart. Bul. 32: 275-278.

40. Nagel, C. M., and L. T. Richardson. 1951. Tomato leaf spot control. South Dakota Agr. Exp. Sta. Cir. 91.

41. Neergaard, P. 1945. Danish species of Alternaria and Stemphylium, 560 pp. Copenhagen.

42. Nelson, Ray. 1949. Control of celery early blight in 1948 and 1949. Michigan Agr. Exp. Sta. Quart. Bul. 32: 562-574.

43. Parris, G. K. 1948. Watermelon disease control. Florida State Hort. Soc. Proc. 1947: 147-150.

44. __________. 1950. Recent advances in watermelon disease control. Florida State Hort. Soc. Proc. 1949: 146-150.

45. __________, and L. H. Stoner. 1948. Spraying for disease control in Florida. Florida State Hort. Soc. Proc. 1947: 93-94.

46. Reddy, C. S. 1950. Breeding and selection of better resistant strains of melons. Iowa Agr. Exp. Sta. Ann. Rept. 1949: 162-163.

47. Reid, W. P., and R. M. Brein. 1948. Control of anthracnose on dwarf beans. New Zealand Jour. Sci. Tech. 29A (6): 304-306.

48. Scheffer, R. P. 1950. Anthracnose of crucifers. North Carolina Agr. Exp. Sta. Tech. Bul. 92.

49. Stoddard, D. L. 1949. Early blight of celery. Florida Agr. Exp. Sta. Ann. Rept. 1948-49: 209-212.

50. Strong, M. C. 1949. Comparison of fungicidal sprays for control of tomato blights. Michgian Agr. Exp. Sta. Quart. Bul. 32: 338-347.
51. Vaughn, E. K. 1952. Control of celery late blight. (Abst.). Phytopath. 42: 519.
52. Walker, W. W., and G. E. Weber (Revised by G. K. Parris). 1949. Diseases of watermelons in Florida. Florida Agr. Exp. Sta. Bul. 459.
53. Walter, J. M., D. G. A. Kelbert, and J. R. Beckenbush. 1949. Organic fungicides for the control of foliage diseases of vegetables. Florida Agr. Exp. Sta. Ann. Rept. 1948: 125-128.
54. Wellman, F. L. 1949. Successful spray control of Alternaria blight of petunias grown for seed in Costa Rica. Plant Dis. Reptr. 33: 69-72.
55. Wilson, J. D. 1943. Preliminary results on the control of tomato anthracnose. Ohio Agr. Exp. Sta. Bimo. Bul. 28: 34-37.
56. ___________. 1944. Further observations on the control of tomato anthracnose. Ohio Agr. Exp. Sta. Bimo. Bul. 29: 56-63.
57. ___________. 1944. Organic fungicides and the control of vegetable diseases in Ohio. Ohio Agr. Exp. Sta. Bimo. Bul. 30: 49-61.
58. ___________. 1944. Ten years of carrot spraying with various copper containing materials. Ohio Agr. Exp. Sta. Bimo. Bul. 29: 63-74.
59. ___________. 1944. The control of celery blights with bordeaux, the fixed coppers with and without sulfur, and fermate. Ohio Agr. Exp. Sta. Bimo. Bul. 29: 94-110.
60. ___________. 1949. Summary of vegetable disease control experiments conducted in Ohio in 1949. Ohio Agr. Exp. Sta., Botany Mimeo. Pub. No. 8.
61. ___________. 1951. A summary of the vegetable disease control experiments conducted in Ohio in 1950. Ohio Agr. Exp. Sta. , Botany Mimeo. No. 10.
62. ___________. 1952. Tomato experiments at Stryker in 1951. Suppl. to Ohio Agr. Exp. Sta. Botany Mimeo. No. 10.
63. ___________. 1952. Vegetable disease control experiments in Ohio in 1951. Ohio Agr. Exp. Sta. Botany Mimeo. No. 13.
64. ___________. 1953. A summary of disease control experiments in Ohio in 1952. Ohio Agr. Exp. Sta. Botany Mimeo. No. 14.
65. ___________, and H. A. Runnels. 1945. Comparative ability of the fixed coppers to control ginseng blight. Ohio Agr. Exp. Sta. Bimo. Bul. 29: 135-144.
66. ___________, and ____________. 1945. A comparison of various carbamates for the control of bean anthracnose. Ohio Agr. Exp. Sta. Bimo. Bul. 30: 189-191.
67. ___________, and H. C. Young. 1945. Comparison of various fungicides, diluents, and adhesives in controlling Cercospora leaf spot of sugar beets. Ohio Agr. Exp. Sta. Bimo. Bul. 30: 62-73.
68. Wilson, J. W. 1950. Cercospora blight of celery. Florida Agr. Exp. Sta. Ann. Rept. 1949: 172.

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